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THE NATURAL REGIONS OF MEXICO

By E. M. SANDERS

Mexico claims the attention of the people of the United States more than any other foreign country, for it is at their door. In the southwestern states one can look over the border into Mexico without realizing that it is a foreign country. The international frontier follows no great physical barrier, and the same general sort of landscape continues across it without interruption. The wide grassy plains of Texas and New Mexico sweep southward into Mexico under new names but with many of the climatic and vegetal features familiar to us north of the Rio Grande. The plateau country farther west has its replica across the border.

Although little difference exists along the border, yet as one journeys southward the contrast with the United States increases. The relief is modeled on a much grander scale than in the border region. The country begins to assume a tropical facies. In fact Mexico becomes a very foreign land indeed. The progressive changes in this southward direction, as also the changes encountered from east to west, define several distinct regions which it is the purpose of this article to describe.

GENERAL FEATURES

We may start with the conception of a great land mass, the core of which was formed of ancient rocks of great resistance, while on its surface there was deposited a thick series of strata of younger, softer rock. The latter became much crushed and folded, forming, besides many groups of isolated mountains, two great bordering ranges—a very imposing range along the western shore and one of lesser proportions that skirted the eastern edge of the land. The latter coast was bordered by a wide continental shelf, the former, by ocean depths. After erosion had worn down the entire surface to a state of moderate relief the mass was uplifted many thousands of feet, a part of the continental shelf being thus transformed into coastal plain, now wide, now narrow, and an immense plateau being created, bounded on three sides by enormous escarpments. The rejuvenated streams have already incised deep valleys in the edges of the plateau, and are pushing back the heads of their valleys vigorously into the interior, although as yet dissection is in an early stage. Associated with the earth movements, volcanic forces have built up a multitude of symmetrical cones upon the plateau surface, their eruptive materials burying whole sections of the former relief, particularly along the western and southern rims of the highlands.¹

¹ Bosquedo Geológico de México, *Inst. Geol. de México Bol. No. 4, 5, 6, 1896*. The physiographic provinces worked out from this geological survey correspond very closely with those given in "The Physiography of Mexico," by W. N. Thayer, *Journ. of Geol.*, Vol. 24, 1916, pp. 61-94.

Northern Mexico is bordered on the east by a coastal plain stretching far inland, behind which rises a step-like escarpment leading up to the plateaus and high plains of the interior. The plateau land continues throughout the center of Mexico, merging westward into the rough mountainous land of the Western Cordillera. An exceedingly steep escarpment borders this cordillera on the west, dropping down to a wide stretch of desert in the extreme north and to a narrow coastal plain farther south.

As one journeys southward there is a gradual change since the movement of uplift was greater in the southern part and at the same time the continental shelf was narrower there. The change is first noticeable on the eastern side. Here the breadth of the coastal plain diminishes, and the height of the plateau that forms the interior increases, with the result that the eastern escarpment becomes formidable. The farther south one goes the more accentuated becomes this feature until the nineteenth parallel is passed. In addition to the increase in height the plateau tapers towards the south, becoming narrower and narrower until at the isthmus of Tehuantepec it comes to an abrupt end.

Both the great plateau of the interior and the coastal plains are a distinct continuation of North America, but to the south of the isthmus the structure of the country is allied to that of Central America. This southern portion consists of another plateau (insignificant in size and importance in comparison with the great plateau north of the isthmus), bordered by an extensive coastal plain on the side facing the Gulf of Mexico. This coastal plain continues northeastward forming a part of the peninsula of Yucatan.

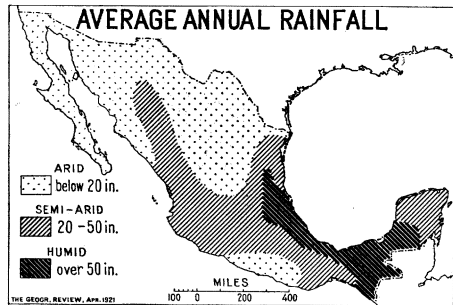


FIG. 1.—Diagrammatic map of mean annual rainfall of Mexico. For a more detailed map see Fig. 10 on p. 255.

CLIMATIC REGIONS

A study of the development of human activities and of land forms in Mexico emphasizes rainfall as the all-important factor. Basing the classification on the annual rainfall, the climatic regions of Mexico can be divided into three groups: (1) Arid, (2) Semi-arid, (3) Humid. The extent of these regions is shown on the map (Fig. 1). The area classed as arid has drought during the greater part of the year, the average annual rainfall being less than 20 inches. The semi-arid areas have a rainy season of about the same length as the dry season, with an annual rainfall of less than 50 inches but greater than 20 inches. The humid areas have rain during more than half the year and an annual rainfall of over 50 inches.

Each of these main divisions comprises many varieties due to difference

in situation with regard to the rain-bearing winds and to differences of altitude. The rain-bearing winds for the most part come from the east, and thus the eastern part of each division is rainier than the western part. For example Sonora is very largely desert, while Chihuahua has enough rain to allow considerable agricultural development.

To an even greater degree does altitude contribute to variation in climate. Corresponding to the coastal plain, escarpment, plateau, and lofty mountain ranges are four clearly defined climatic zones. This altitudinal zoning has played such an important rôle in the development of the country that, well known as it is, it deserves emphasis. As one passes inland the first zone is

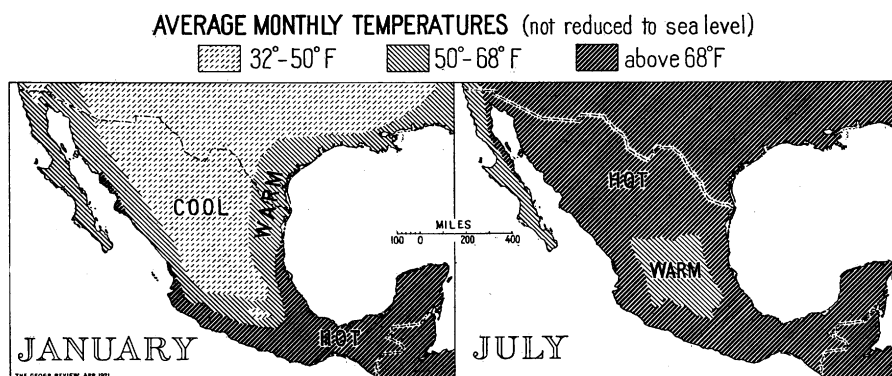


FIG. 2.—Diagrammatic maps of mean monthly temperatures in Mexico in January and July. For a map of mean annual temperature see Fig. 9 on p. 254.

tierra caliente, the hot country; next the zone of the escarpment, *tierra templada*, the warm lands; then that of the plateau, *tierra fria*, the cool zone; and lastly the zone of the high mountains, sometimes called *tierras heladas*, the frozen heights. On the accompanying maps are shown the actual average temperatures in January and July, not reduced to sea level. The graphs in Figure 3 epitomize the whole.²

Coastal Regions

The coastal plain bordering the Gulf of Mexico presents four distinct types of relief. First is the Tamaulipas strip stretching from the Rio Grande to a short distance south of Tuxpan. Physiographically it is a continuation of southeastern Texas,³ an almost featureless plain, margined by wave-built reefs, and running inland for many miles. As it approaches the mountains it becomes more uneven, gradually merging into the foothills of the escarpment.

² The classification, etc., is based upon (1) data supplied in manuscript by the U. S. Weather Bureau, Washington, D. C., 1919, (2) Julius Hann: *Handbuch der Klimatologie*, Stuttgart, 1910, Vol. 2, pp. 318-330.

³ W J McGee: The Lafayette Formation, *12th Ann. Rept. U. S. Geol. Survey*, 1890-91, Part I, pp. 353-521; reference on p. 376.

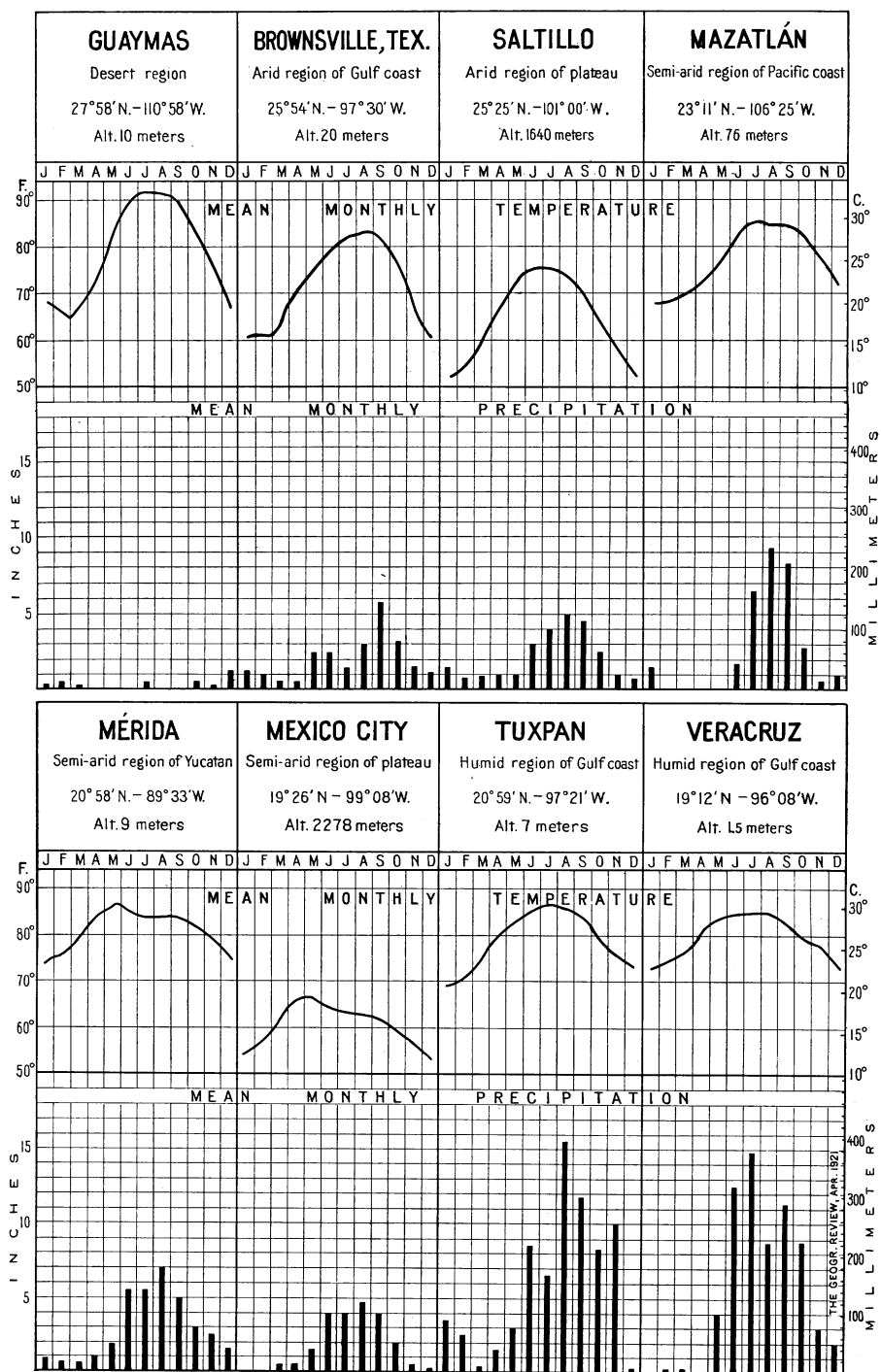


FIG. 3—Temperature and rainfall graphs.

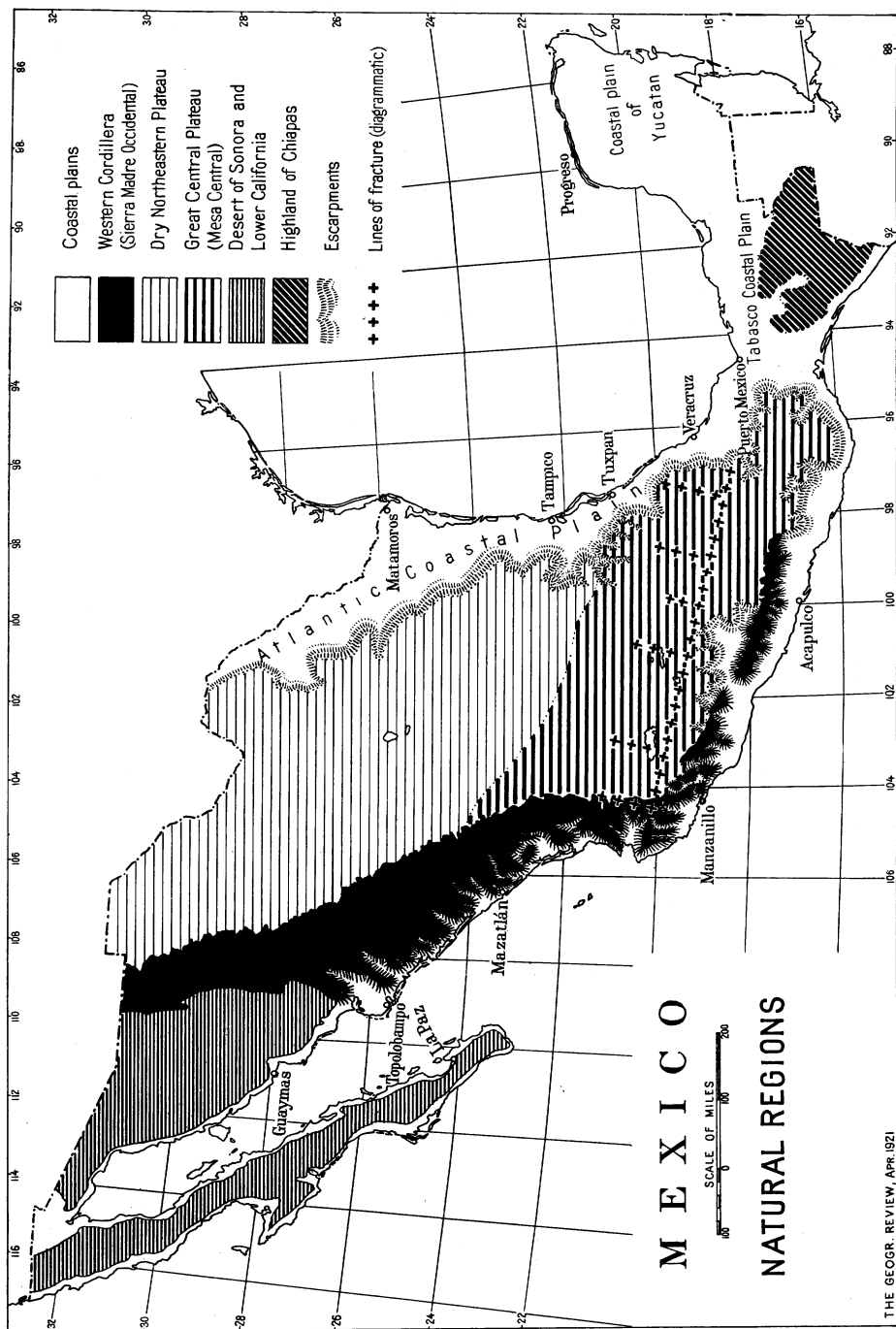


FIG. 4.—National regions of Mexico. Scale 1:17,500,000. The diagrammatic fracture lines are after Felix and Lenk, work cited in footnote 17.

The vegetation is sparse on account of the aridity of the climate. Behind the dunes and swamps of the littoral the ground is covered with chaparral, in which dense growth of brush mesquite is typical. Toward the south the climate becomes more favorable to vegetation, and islands of tropical trees appear among the mesquite brush. Clumps of fig trees and palmettos break the monotony of the landscape, and the mesquite itself is modified, becoming a tree some 20 feet in height. Near the coast the chaparral alternates with wide savanas.⁴

The Veracruz strip differs in several respects from the section just described. The width of the plain diminishes, almost disappearing in the southern part. The lagoons are smaller and in places disappear altogether. The altitude of the bordering escarpment is greatly increased. Rainfall is heavier and gives rise to many permanent streams, and thus the coast line is broken by many river mouths. The southern part of the plain is much broken by the spurs of the dissected edge of the plateau and the relief is still further complicated by volcanic action. Great cones are perched near the edge of the escarpment, while the volcano of Tuxtla rises in the midst of the plain itself.

The natural vegetation of this division is dense jungle, formed partly by thickly packed mesquite brush and partly by plants of the tropical forest. Here and there are natural clearings, however, open savanas which form rich pasture land. In the southern part of the plain are two well-marked zones of vegetation: the valleys are filled with thick jungle, while the crests of the encroaching spurs are clothed with coarse grass broken by clumps of trees. Large stretches of land have been cleared, and plantations established. Coffee is grown successfully on the upper slopes of the ridges, tropical fruits on the lower slopes, and on the plain itself crops such as sugar cane thrive.

The third, or Tabasco division, is in many ways like the Tamaulipas strip. It also borders a shallow sea and has so slight a slope that the streams have next to no current. They end in swamps, and wind and waves build up sandy spits and islands, eventually forming lagoons. The conditions for ports are even worse than in Tamaulipas, for the shelterless coast is exposed to the full fury of the storms that sweep from the north. Behind the shore line a coastal plain covered with dense vegetation stretches far inland. Rolling country succeeds it, beginning about 50 miles inland and continuing in a broad strip parallel to the coast.

The vegetation ranges from the same sort of jungle that covers the Veracruz strip to the dense tropical forests of southern Mexico. An impenetrable wall of shrubs and creepers guards the dark, damp interior, which is roofed in by the tops of lofty trees whose branches are matted together by creeping plants. In places along the rivers stretch wide savanas.

⁴Vegetation largely based on J. W. Harshberger: *Phytogeographic Survey of North America* (Series: *Die Vegetation der Erde*, Vol. 13), New York, 1911, pp. 633-672. See also Isaac Ochoterena: *Las regiones geográfico-botánicas de México*, *Bol. Soc. Mexicana de Geogr. y Estadística*, Vol. 8, 1919, pp. 221-231.

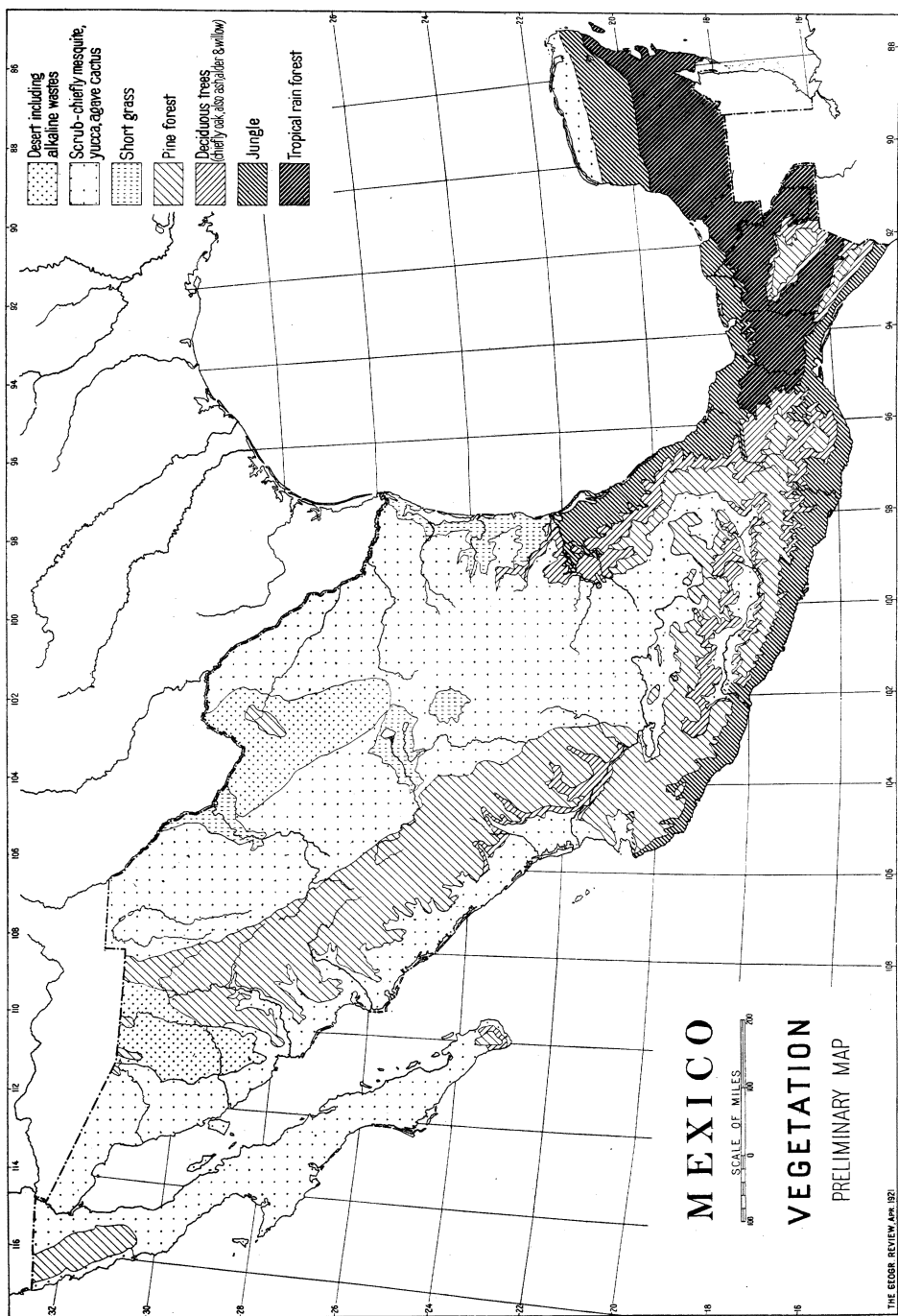


FIG. 5—Vegetation map of Mexico. Scale 1:17,500,000.

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THE PENINSULA OF YUCATAN

The fourth division,⁵ where the Gulf Plain attains its maximum width, is the peninsula of Yucatan. Structurally this section is quite distinct, the peninsula being built up of almost horizontal layers of an extremely soluble limestone. A karst topography is the result, there being no surface streams but an extensive subterranean system and a characteristic development of sink holes, known locally as *cenotes*.⁶ With the exception of a single range of hills in the western part, the whole peninsula is flat or very gently rolling, much cut up by shallow hollows separated by low ridges averaging six to ten feet in height. The northern and western coasts are low and flat, except for about 30 miles south of Campeche, where low hills, which run across the peninsula, reach the shore line and define a rocky coast fringed by coral reefs. Coral reefs also form a barrier along the entire length of the eastern coast. The northern coast is bordered by an almost continuous sand bank enclosing an extensive brackish lagoon.

The northern coastal strip is dry and covered by dense chaparral. The low compact shrubby growth is broken here and there by stretches of grassland. Strange to say, this unprepossessing district has become one of the richest agricultural regions of Mexico, the soil and climate providing ideal conditions for the production of sisal fiber (henequén). Furthermore the aridity makes it possible to clear the land by burning the brush. Formerly the work of extracting the fiber was so arduous as to make production on a large scale impossible, but lately the invention of a machine to do this work, and an increased demand for the product, have caused the industry to progress by leaps and bounds and have made this arid district one of the most prosperous in the country.⁷

THE PACIFIC COASTAL REGIONS

The Pacific seaboard of Mexico is not important either as regards size or production. In general the strip of lowland between the high mountains and the sea is narrow, while nearly the whole of it suffers from aridity, desert alternating with semidesert as one journeys from north to south.

The northern desert part comprises both the peninsula of Lower California and the state of Sonora. The peninsula is a partially submerged mountain range, the Gulf of California, which separates it from the mainland, being a great flooded valley. The latest earth movement has re-elevated a narrow coastal plain on both sides of the peninsula. The eastern shore of the Gulf of California is formed by the coastal plain of the states of Sonora and Sinaloa which in places attains a width of 70 miles. It is bordered by sand dunes, and both coast and hinterland are desert.

⁵ Karl Sapper: Sobre la geografía física y la geología de la península de Yucatán, *Inst. Geol. de México Bol. No. 3*, 1896.

⁶ L. J. Cole: The Caverns and People of Northern Yucatan, *Bull. Amer. Geogr. Soc.*, Vol. 42, 1910, pp. 321-336.

⁷ Ellsworth Huntington: The Peninsula of Yucatan, *Bull. Amer. Geogr. Soc.*, Vol. 44, 1912, pp. 801-822.

South of Sonora the coastal plain is very narrow, in places disappearing altogether, and it is cut off from the interior by the almost impassable mountains of the Western Cordillera system.⁸ Beyond Cape Corrientes the coastal plain broadens somewhat and is bordered in places at its seaward edge, by lagoons and sand hills which form a marked contrast to the lofty cliffs succeeding it and continuing southward until the coastal strip of Chiapas is reached. This latter is the only part of the Pacific coast which does not suffer from aridity.

The Escarpments

The escarpments are the edges of the uplifted plateau which forms the interior. An examination of a contour map of Mexico shows that three main types are embraced herein: the step-like escarpment of the northeast, the ragged escarpment of the southern and southeastern edge of the plateau, and the cliff-like escarpment of the Western Cordillera. The first type extends from the border to about the latitude of Tampico. Its low and step-like character is most apparent in the northernmost part. Here the plateau is less than 2,000 feet high at a distance of 200 miles inland. Erosion of the horizontally disposed newer rock that covers the hard core causes the ground to rise in easy steps as one journeys inland from the sea. The gradient is rendered still less steep by numerous alluvial fans washed down by the short-lived streams of the rainy season. Farther south, however, the climate becomes less arid, permanent streams are frequent, and the plateau edge is cut up into a ragged fringe of spurs. The plateau also rises in height, attaining over 5,000 feet inland from Tampico, and at the same time it approaches nearer the coast, the escarpment being only about 100 miles inland. Thus the difficulty of crossing the northeastern escarpment gradually increases as one goes toward the south, and the step-like escarpment of the north grades into the ragged escarpment of Veracruz. The altitude of this escarpment is much greater than that of the step-like escarpment; the plateau surface averages 7,500 feet in height while from its edge rise lofty volcanic peaks, for example, Orizaba, over 18,500 feet in height.⁹

A change of climate still further accentuates the difference between the ragged and the step-like escarpments. The climate of the Veracruz region is by far the more humid, and in consequence the course of erosion is very different. Instead of the edge of the escarpment being blunted by alluvial fans it is rendered still more difficult for transportation by dissection. The ravines, called *cañadas*, are often more than 2,000 feet in depth. Vulcanism in the form of cones and lava flows still further complicates the relief.

⁸ Carl Lumholtz: The Sonora Desert, *Geogr. Journ.*, Vol. 40, 1912, pp. 503-510.

W J McGee, in his work on the Seri Indians (*17th Ann. Rept. Bur. Amer. Ethnol.*, 1895-96, Part I, pp. 9-50) gives a description of the physical character of this region. See also, by the same author, the article "Papagueia," *Natl. Geogr. Mag.*, Vol. 9, 1898, pp. 345-371, and W J McGee and W. D. Johnson: Seriland, *Natl. Geogr. Mag.*, Vol. 7, 1896, pp. 125-133.

⁹ *Geogr. Journ.*, Vol. 51, 1918, pp. 190-191.

The vegetation of these two escarpments is as distinctive as the relief. The northern part of the step-like escarpment is unproductive, being covered with mesquite and poor grass. As one goes south the increasing humidity causes the grass to improve in quality, and it provides rich grazing land. Farther south still the ragged escarpment of Veracruz forms one of the richest agricultural regions of the country. The natural vegetation is deciduous woodland, principally oak and pine, with grass on the upper slopes, while semitropical forests occupy the lower slopes. The pine forests, which supply timber to the treeless plateaus of the interior, are dense at an altitude of 6,000 feet and at a height of 8,000 feet dominate other vegetation. From 4,000 to 6,000 feet altitude there runs a belt of mixed pine and oak. Where the land is cleared plantations of coffee, tobacco, sugar cane, and tropical fruits thrive at the lower altitudes, and on the higher ground the grains of temperate lands can be grown.

THE WESTERN ESCARPMENT

The western escarpment forms a striking contrast to the fertile escarpment of Veracruz. It consists of the barren, ravine-scored flank of the Western Cordillera, which cuts off the coastal regions from the interior. In the northern part the Sonoran slope is less steep, but the land is desert and forms as great a barrier as do the mountains in the more southern section. Owing to the aridity of the climate large stretches of the western escarpment are almost without vegetation, and considerable areas are covered with desert plants and shrubs which are of no economic value. Where the rainfall is sufficient, however, extensive forests cover the lower slopes, producing valuable woods such as mahogany and logwood. Above 4,500 feet this vegetation gives place to oak forests, which flourish up to 8,000 feet, beyond which conifers dominate. The lower slopes are used for growing corn, sugar cane, tobacco, cotton, and fruit in regions where enough rain falls or where irrigation is possible.¹⁰

The Highland

If classified according to general structure, the highland region falls into two parts: the northern portion, comprising the greater part of the country and terminating at the isthmus of Tehuantepec; and the minor southern part, comprising the mountains of Chiapas.

The northern part of the Highland is divided into four natural regions, the upland desert of Lower California and Sonora, the Western Cordillera, called the Sierra Madre Occidental, the dry northeastern plateau, and the great Central Plateau (Mesa Central).

THE DESERT OF SONORA AND LOWER CALIFORNIA

Lower California is a narrow strip of mountainous land with a general northwest-southeast trend, parallel to the chief mountain ranges of the

¹⁰ H. M. Wilson: *Topography of Mexico*, *Bull. Amer. Geogr. Soc.*, Vol. 29, 1897, pp. 249-260.

Pacific coast. It consists of a core of ancient rock which had been carved into a state of high relief by erosion before it was depressed and buried under newer strata of great thickness. It was again uplifted and a large part of the newer deposits eroded. Thus its relief is of two types, ancient sharp-peaked mountains, disclosed where the newer strata have been removed, and mesas often capped with lava formed by the dissection of the newer strata.

In the extreme south there is sufficient rain to allow permanent streams, and the granite mountains are carved into deep valleys. In the northern part, where the relief culminates in the San Pedro Mártir Sierra, there are also permanent streams. As a rule, however, the aridity is broken only by rains of short duration and torrential character, and dry deep water-courses with great alluvial fans are the result. The natural vegetation as a whole is distinguished by its extraordinary desert flora, chiefly of thorny growths, of cactus, agaves, and yuccas including many peculiar species.¹¹

The upland desert of Sonora takes in the northern part of the land on the eastern side of the Gulf of California. It is an interesting example of erosion in an arid climate. The surface consists of a series of plains, broken by buttes, mesas, and sierras, which are probably the worn-down stumps of parallel northwest-trending chains of mountains. The plains on close inspection prove to be basins, not always landlocked but without drainage to the sea. Near the coast many of the basins are open to the sea, and as one passes inland each succeeding basin lies higher than its neighbor, the altitude gradually increasing from sea level to 3,500 feet. Some of the basins in the western part communicate with each other, but the more eastern basins are completely shut in. In the western part the basin floor appears to be composed of solid rock covered with a thin veneer of sand and gravel. The phenomena suggest that the region is in a mature stage of the cycle of erosion in an arid climate.¹²

In the desert of Sonora the vegetation is characterized by its discontinuity. There are wide stretches where there is no vegetation, alternating with areas where there is sufficient water and soil to support a growth of cactus and spiny scrub. Mesquite, *palmo verde*, and the Sonoran greasewood are the chief arborescent forms, but it is the cactus that forms the most striking feature.

THE WESTERN CORDILLERA

The Western Cordillera stretches like a one-sided spine along the western coast through the length of the land. Definite information on this natural

¹¹ S. F. Emmons and G. P. Merrill: Geological Sketch of Lower California, *Bull. Geol. Soc. of Amer.*, Vol. 5, 1894, pp. 489-514.

A. W. North: The Uncharted Sierra of San Pedro Mártir, *Bull. Amer. Geogr. Soc.*, Vol. 39, 1907, pp. 544-554.
Gustave Eisen: Explorations in the Central Part of Baja California, *Bull. Amer. Geogr. Soc.*, Vol. 32, 1900, pp. 397-429.

E. W. Nelson: A Land of Drought and Desert—Lower California, *Natl. Geogr. Mag.*, Vol. 22, 1911, pp. 443-474.

¹² W. J. McGee: Sheetflood Erosion, *Bull. Geol. Soc. of Amer.*, Vol. 8, 1897, pp. 87-112. Compare also W. M. Davis: Geographical Essays, Ch. 15, "The Geographical Cycle in an Arid Climate."

region is scant: it has been little explored, and its structure appears to be highly complex. There is, however, without doubt a system of fold mountains running in great ranges roughly parallel to the Pacific coast. These mountains are about 7,000 feet high, while many peaks rise to over 12,000 feet. The ranges are complicated by a great amount of volcanic activity, cones and lava flows in all stages of dissection occurring among them.¹³ On the west the mountain flanks are more or less cut up by ravines. On the east, on the contrary, the mountains grade into the mesa region, and their flanks are not cut to anything like the same degree, since on this side the rivers are intermittent, ending in closed basins, and the gradients of the stream beds are not as steep as on the western side. The course of erosion here tends rather to lessen than to accentuate the relief.

The Cordillera embraces many zones of vegetation. The dry lower slopes of the northern part are covered with grass and mesquite, which give place to forests of oaks, mountain cedars, and pines as the ground rises and the rainfall increases. The higher parts of the mountains are forested with pine where the rainfall is deficient, but where it is abundant live oaks mingle with the pine. The timber resources of this region constitute a vast source of potential wealth. As yet difficulty of access restricts exploitation, although, even so, the forest products from some of the states, Durango and Chihuahua for example, are not inconsiderable.

THE ARID PLATEAU OF THE NORTHEAST

The arid northeastern plateau is formed of strata which still remain horizontal for the most part. Differences in climate have caused quite different erosional effects in the western and eastern parts. There are local names for the distinctive land forms of each part, which suggest distinguishing names for each region. The western part is a region of flat-topped mountains, mesas and intervening broad, level depressions. The eastern part has as its typical form of relief the closed-in, basin-like hollows known as *bolsons*, and this may be termed the bolson country. The mesas are as a rule about the same height, though there are differences in level and slight tilting due to the differential uplift. The upper portions of the escarpments which terminate the mesas are precipitous, whether through erosion or faulting; the base is often covered by extensive gravel deposits.¹⁴

The bolson country is situated on the east of the mesa regions. There is no distinct boundary between the two. The same general structure probably underlies each, but the surface forms have been differentiated by erosion. The relief becomes less pronounced, the level of the land lower, and the climate more arid, as one journeys eastward. The sides of the mesas become

¹³ O. H. Howarth: The Western Sierra Madre of Mexico, *Geogr. Journ.*, Vol. 6, 1895, pp. 422-438.

E. O. Hovey: The Western Sierra Madre of the State of Chihuahua, Mexico, *Bull. Amer. Geogr. Soc.*, Vol. 37, 1905, pp. 531-543.

¹⁴ R. T. Hill: Preliminary Notes on the Topography and Geology of Northern Mexico and Southwest Texas, and New Mexico, *Amer. Geologist*, Vol. 8, 1891, pp. 133-141.

less precipitous, the streams are fewer, and none are permanent, while the plazas give place to bolsons. The bolsons are little below the general surface of the surrounding plateau, which here averages 5,000 feet in height. The basins are aggraded areas filled with waste washed down by streams or carried there by the wind. Besides bolsons other features of this country are the ever-shifting sand dunes and the monoclinical mountains which mark the edges of tilted blocks of strata.

The vegetation is sparse. The land in its natural state produces a desert flora—bunch grass, cactuses, and yuccas, and such woody plants as the mesquite and the guayule. Human occupation of the region is practically confined to stock raising and mining, save where the possibility of irrigation changes the whole aspect of affairs and renders the land exceedingly productive. An example of the transformation of semidesert into rich plantations is found in parts of the Bolson de Mapimi (Coahuila and Durango), where cotton and tobacco are grown for export, as well as food crops for home consumption.¹⁵

GREAT CENTRAL PLATEAU

The natural regions of the highlands already described sink into insignificance beside the great Central Plateau, the fourth and, from the viewpoint of human occupation, the most important of these divisions. It contains the great cereal region, upon which, from time immemorial, the life of the country has depended, and from its depths come the precious metals which have made Mexico of such importance to the world at large. The plateau is a triangular-shaped area stretching southeastward from an east-west line 22° 30' N. It is bounded on the south and east by steep escarpments, cut by innumerable streams into deep ravines. On the west and north it grades imperceptibly into the Western Cordillera and the northeastern plateau, differing from the latter in climate rather than in topography. The core of the plateau is formed of ancient crystalline and sedimentary rock with igneous intrusions of various dates, the whole mass having been folded, faulted, crushed, and subjected to long-continued erosion before the uplift that ushered in the present cycle of erosion.¹⁶ This uplift was accompanied by a tilt to the north. Thus the southern edge has been raised higher than the northern part. Some of the lines of fracture are shown in Figure 4; the great scarp faults are due to them, and along them are piled the cones produced by violent bursts of volcanic activity.¹⁷ The present result of the long process is that there are two mountain types, residuals and volcanic cones. The older residual mountains are distinguished by rounded summits and long, low ridges. The volcanic peaks are of much greater height, completely dominating the older relief. They show the forms usually found

¹⁵ La República Mexicana: Coahuila, *Reseña Geográfica y Estadística*, Paris and Mexico, 1909, pp. 41–43.

¹⁶ Virlet d'Aoust: Observations sur le système des montagnes d'Anahuac ou de l'Amérique Centrale, *Bull. Soc. de Géogr. de Paris*, Vol. 13, 1877, pp. 241–274.

¹⁷ Felix and Lenk: Über die tectonischen Verhältnisse der Republik Mexico, *Zeitschr. Deutsch. Geol. Gesell.*, Vol. 44, 1892, p. 303.

in volcanic regions, cones in various stages of dissection, extensive flows, lava plateaus, etc. The group of mountains to the northeast of Mexico City is an example of the older, or residual, type of mountains, while Popocatepetl and Ixtaccihuatl are volcanic cones.¹⁸

The Central Plateau is by no means all mountains. Among its most characteristic features are wide stretches of level land. These are aggraded areas sometimes still occupied by shallow lakes, sometimes in a later stage, being drained by streams which have cut through the basin rims and captured the areas of interior drainage. The climate is rainy enough to cause vigorous stream action, which is rendered more powerful by the great height of the plateau. On the eastern edge the climate is the most humid and there erosion is most vigorous. The outlying district of Oaxaca, which has not had its drainage system interrupted by volcanic disturbances, is almost entirely cut off from the main mass of the plateau and offers a highly dissected surface, showing what would have happened to the entire plateau, after the uplift, had not the process of erosion been blocked by vulcanism.

The Central Plateau has many zones of vegetation. The high plains of the interior suffer from lack of rain, being grass-covered where there is sufficient moisture and suitable soil, and barren where the soil is alkaline or sandy or where local topography most completely cuts off precipitation. The foothills bordering the plains are also generally devoid of timber. The lower slopes of the mountains are covered with scrub forests. Spruce and fir forests clothe the upper slopes of some of the higher ridges while the escarpments and the outliers of the plateau have a belt of deciduous trees below the pine forests. The timber line lies at an altitude of 11,000-13,000 feet, at which elevation there are often extensive alpine meadows. The snow line is at about 15,000 feet.

THE HIGHLAND OF CHIAPAS

South of the isthmus rises the highland of Chiapas, a plateau of small dimensions, whose maximum width is only 150 miles and whose length is hardly more. Its maximum height is about 6,000 feet. As in the Central Plateau two types of relief are distinguishable. In the north there are flat-topped mesas; in the south there are sierras showing sharp ridges. In the northern part the ground rises in a series of terraces, and there is a belt of well-marked *cuestas* that run from southeast to northwest. There is evidence of considerable volcanic activity in this section: the southern part on the contrary has but one volcanic peak.

The vegetation of the plateau of Chiapas resembles that of the southern escarpment and the outliers of the plateau. That part which is high enough to be out of the tropical zone has a belt of deciduous trees with clearings of

¹⁸ Ezequiel Ordóñez: Observaciones relativas á los volcanes de México, *Memorias Soc. Científica "Antonio Alzate,"* Vol. 8, 1894-95, pp. 183-196.

grassland which form rich pasture. Still higher the mountain slopes are covered with pine forests. The agricultural possibilities of the region are great; the lower slopes and foothills can be used for tropical crops such as sugar, coffee, rubber, cacao; and on the upper slopes fiber plants can be grown. The timber of the mountains forms a valuable resource.¹⁹

¹⁹ Emilio Böse: Reseña acerca de la geología de los estados de Chiapas y Tabasco, *Inst. Geol. de México Bol. No. 20*, 1905, pp. 7-20.

Karl Sapper, work cited in footnote 5, and map at the end of the volume.